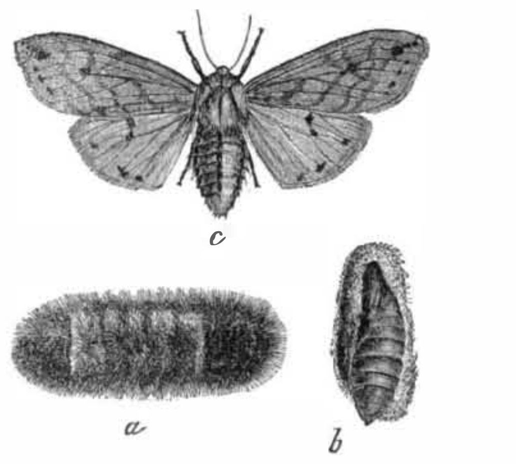
[From the Fourth Annual Report of Charles V. Riley, State Entomologist of Missouri.]

THE ISABELLA TIGER MOTH.

The larva of this insect, *a*, is very common with us, and is familiarly known as the hedgehog caterpillar. It is thickly covered with stiff black hairs on each end and with reddish hairs on the middle of the body. These hairs are pretty evenly and closely shorn so as to give the animal a velvety look; and as they have a certain elasticity, and the caterpillar curls up at the slightest touch, it generally manages to slip away when taken into the hand.

It feeds on plantain, clover, dandelion, grasses, and a variety of other plants, and after passing the winter in some sheltered spot, rolled up like a hedgehog, it comes out

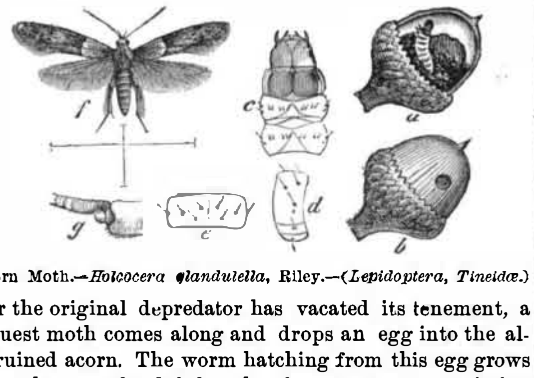


The Isabella Tiger Moth—*Arctia Isabella*, Smith.—(*Lepidoptera, Arctiadæ.*)

in the spring to feed upon the first herbaceous vegetation, and finally spins its cocoon (*b* represents one cut open, giving a view of the chrysalis) and goes through its transformations. The cocoon is composed principally of the caterpillar's hairs (which are likewise barbed) interwoven with coarse silk. The chrysalis is brown with tufts of very short golden bristles, indicating the positions of the larval warts, and with a tuft of barbs at the extremity. The moth is of a dull orange color, with the front wings variegated with dusky, and spotted with black, and the hind wings somewhat lighter and also with black spots.

THE ACORN MOTH.

The mast, which is so valuable to the swine breeder in the oak land sections of Missouri, is often very seriously affected and greatly diminished in quantity by the workings of the larva or grub of a species of long snouted nut weevil (*balaninus rectus*, Say.) The female, with her long bill, pierces a hole in the young acorn, and deposits therein an egg which gives birth to a legless arched grub with a brown head. This grub devours during the summer the contents of the acorn, and in the autumn drops, with the rifled fruit, to the ground, where it soon gnaws its way out through a circular hole and buries itself for the winter. It becomes a pupa in the spring, and eventually issues as a beetle.



The Acorn Moth.—*Holcocera glandulella*, Riley.—(*Lepidoptera, Tineidæ.*)

After the original depredator has vacated its tenement, a little guest moth comes along and drops an egg into the already ruined acorn. The worm hatching from this egg grows fat upon the crumbs left by the former occupant, rioting amid the refuse and securing itself against intruders by closing, with a strong covering of silk, the hole which its predecessor had made in egress. In the winter time, or in spring or early summer, the farmer, who notices three fourths of the acorns under his trees infested, as they have been for the past two years, by this worm, is very apt to consider it the true culprit, whereas it is rarely if ever found in acorns that have not first been ruined by the weevil above mentioned, or injured by some other insect, or in some other way.

This after comer is of a yellowish or grayish white color, often with dark marks on the back, a light brown head, and a horny piece of the same color on the first and last joints, and small hair-emitting dusky points over the body, *c d e*. It is, withal, easily distinguished from the weevil larva by its full complement of six true and ten false legs. It changes to the chrysalis within its borrowed domicile, and the chrysalis gives forth the moth by first pushing partly through the silken door.

The moth, *f*, is ashgray in color, and characterized chiefly by two distinct spots near the middle of the front wings and a transverse pale stripe, well relieved behind, across their basal third. The male differs from the female by the basal joint of his antennæ being much flattened and articulating with the stalk by means of a nodule, *g*. The moths issue all along from the end of April till September. They vary much in size and conspicuity of design.

JOHN E. LAUER, of New York city, produces the acid phosphates for yeast powders by treating bone black first with sulphuric acid and afterwards with muriatic acid.

Correspondence.

[For the Scientific American.]

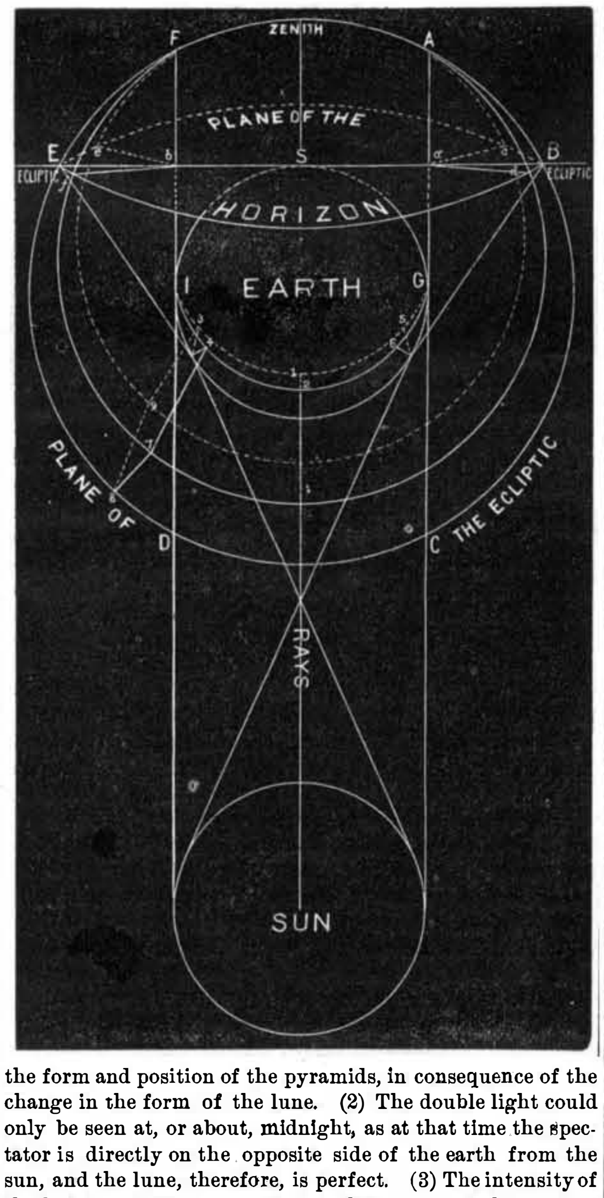
Explanation of the Cause of the Zodiacal Light.

What is known as the zodiacal light is an optical phenomenon caused by the reflection of the rays of the sun from the earth, upon the atmosphere and thence to the spectator.

For the purpose of illustration I have taken the case of the "double light" (a pyramid in the east and one in the west at the same time), as a knowledge of the principle involved in the formation of the double light includes that of the single pyramid.

The most favorable condition under which the zodiacal light can be seen is when the spectator's position is in the plane of the ecliptic, and this is probably the only position from which the double light can be seen at all, the plane of the ecliptic being then perpendicular to the spectator's horizon.

The figure annexed is a representation in perspective of the plane of the horizon (the spectator's station being at S, the earth), showing the lune, G 1 I 2, from which the rays are reflected, as regards the spectator; the atmosphere, A B C D E F, showing the portion illuminated by reflection from the lune, 4, 7, 8, 9, 3, being a section in the plane of the spectator and the sun. The portion of the illuminated atmosphere which alone will be visible to the spectator, at S, will be those parts illuminated by the reflection from the portions of the lune included in the spherical triangles, 5 G 6 and 3 I 4, all the rest being below the plane of his horizon; the reflected rays, 5 *c*, 6 *d*, 3 *e* and 4 *f*, are omitted to avoid confusion in the lines. The visible parts will, therefore, appear to him in the form of the two pyramids, A *a d* B *c*, and F *b f* E *e*, their bases, *a d* B *c* and *b f* E *e*, resting on the horizon, and their apices being limited by the thickness of the atmosphere, *a* A and *b* F. It is evident, therefore: (1) That any deviation of the position of the spectator from the plane of the ecliptic would be attended by a simultaneous change in



the form and position of the pyramids, in consequence of the change in the form of the lune. (2) The double light could only be seen at, or about, midnight, as at that time the spectator is directly on the opposite side of the earth from the sun, and the lune, therefore, is perfect. (3) The intensity of the light would vary according to the nature of the portion of the surface of the earth from which the rays were reflected at the time, as land, water, etc. (4) The brightest part of the pyramids would be the center of the base, on account of the greater thickness, as regards the spectator at S, of the illuminated portion of the atmosphere through that part, that is, along the lines *a* B and *b* E. (5) On the same principle, the moon should also give a zodiacal light. The most favorable time would be when the spectator's position was in the plane of the moon's orbit, a short time before her rising or after her setting, and about the time of the full moon. The moon, however, could not give the double light, because, she being much smaller than the earth, the cusps of the lune would not embrace the whole of the semi-circumference of the earth, and therefore the reflection could not reach that part of the atmosphere above the plane of the spectator's horizon.

The pulsations noticed by some observers are, without doubt, the effect of refraction, either in the body of the atmosphere, or perhaps caused by the irregular motion of its surface (atmospheric waves).

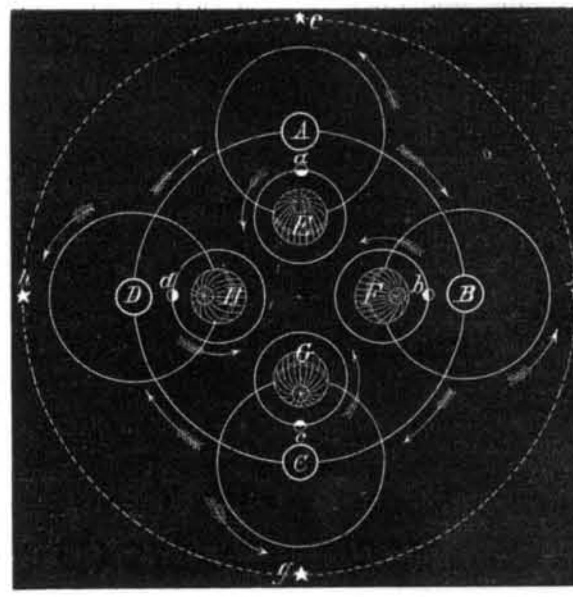
Query: May not the tails of comets be accounted for upon similar principles? In the case of some comets, the enormous length and rapid changes of these supposed appendages appear to indicate the earth's atmosphere as the medium of the second reflection. The question can only be decided by observation. T. R. L.

Mount Airy, Philadelphia, Pa.

Retrogressive Motion of the Sun.

To the Editor of the Scientific American:

In the hopes that my friend and opponent, C. H. B., would



have favored me with his full name, or at least would have replied to me privately, I withheld sending you my diagram showing how precession of the stars is produced by the retrograde motion of the sun. But as he has not complied with my wish, neither opposed me, so far as I know, publicly, and as other astronomers have expressed much surprise at my views and doubts as to their truthfulness (one actually predicts my defeat in case C. H. B. replies): I now present my diagram; and if it fails in one single iota to come up to all the demands of Nature, so far as precession of the stars and recession of the equinoxes is concerned, I will be more than obliged to C. H. B., friend Swift, or any one else to point me to that defect. Instead of a defeat on my part, I am sure of success, and that, no doubt, C. H. B. is beginning to see, or else I am far mistaken; and so will all competent judges, when they study the subject as it deserves.

A B C D in the figure represent the sun in four points of his retrogressive orbit, 90° apart from each other; E F G H represent the earth invariably at her summer solstice, as she is carried backward, as it were, in her orbit, by virtue of solar motion; and *a b c d* represent the moon at four different points of her orbit, also 90° apart from each other, where she will eclipse the sun; *e f g h* represent stars in the ecliptic, or in a circle surrounding the pole of the ecliptic, also 90° apart from each other. The dotted circle represents the ecliptic, the larger ring the orbit of the sun, the lesser rings the orbit of the earth, and the smallest ones the orbit of the moon, and the arrows the direction of movement, respectively, of sun, earth, and moon.

From this it will be seen at once that as A (the sun) retrogrades toward B, the star, *e*, together with all the others, will, as it were, advance eastward; and their rate of apparent motion will be in proportion to that of the sun's real motion. For instance, when the sun reaches B, he will have completed one quarter of his orbit, or 90° of it, and so the stars will have advanced 90°. To move from A to B will take the sun about 6,467 years, and the same time to move from B to C; and so on all around, completing his orbit in 25,868 years. For every ninety degrees the sun retrogrades, ninety degrees is cut off the earth's orbit, as it were. In other words, for every quarter of an orbit the sun completes, the earth comes to her equinoxes one quarter of a year sooner than she would do if the sun were standing still, or if he were pursuing a straight forward course. And so, for every full orbit he makes, the year of the earth is completed 365¼ days sooner than it would have been had the sun been fixed in space. Thus we have 25,868 solar years in 25,867 sidereal years. The truth stands then that, as solar time is prolonged to the amount of one day (less 20 minutes and near 23 seconds) by the motion of the earth direct around the sun every year, so solar time is shortened to the amount of one day in 25,868 days and to one year in the same number of years, by the sun's retrogressive movement in space.

It will now be seen that the so called retrograde "wabble" of the earth is not a gyration, as Newton supposed and as his followers still imagine, but that it is simply a change in her parallelity of polar position, gradually and surely brought about by the retrograde motion of the sun. Precession of the stars and recession of the equinoxes is not therefore peculiar to the earth; but is alike common to and performed in the same length of time by all the planets of our system.

Will C. H. B. or any other interested astronomer be kind enough to examine this theory fairly and minutely, and then answer "yea," or "nay" to it, through the SCIENTIFC AMERICAN, and they will very much oblige its humble author? JOHN HEPBURN.

Gloucester, N. J.

Location of the Million Dollar Telescope.

To the Editor of the Scientific American:

Mr. Alvan Clark, in a letter to *Appleton's Journal*, calls attention to the main difficulty attending the use of great telescopes, namely, the "everlasting commingling of warmer and cooler portions of atmosphere between the object glass and object."

This atmospheric disturbance may be very much lessened by selecting a proper place for the observatory.

Professor Young finds the air at Sherman station, U. P. R. R., to be much clearer than at the Eastern seaboard, and those who have visited the parks of Colorado will remember the great brilliancy of their star light.

It is only necessary to immolate, in the interest of science, a sufficient number either of gentlemen of the Signal Service or volunteers, each on his mountain top, from Pike's Peak to the Himalayas, to find localities where Professor Tyndall himself could not object to the want of optical purity in the atmosphere.

The telescope being once established on its distant peak among the upper trade wind currents, and adjusted for photography, we may all look at once, by using ordinary and well known processes. Each photographic picture, as taken, is to be sent all over the world by copying telegraph, and published next morning in the newspapers. The operations are as follow:

1. A negative is taken, either with instantaneous or very short exposure, and either photo-lithographed, or copied by a gelatin relief print.

2. The print is electrotyped or pressed.

3. The electrotype is gradually cut away by the sharp pointer of a copying telegraph, and simultaneously engraved on a steel cylinder, by a similar machine at each receiving station. This cylinder may then be printed from, or treated as any other engraving.

The great accuracy of workmanship required for these relay engraving engines may be readily attained by milling machines with shaped diamond cutters. S. H. M., JR.

The Kromschroder Gas.

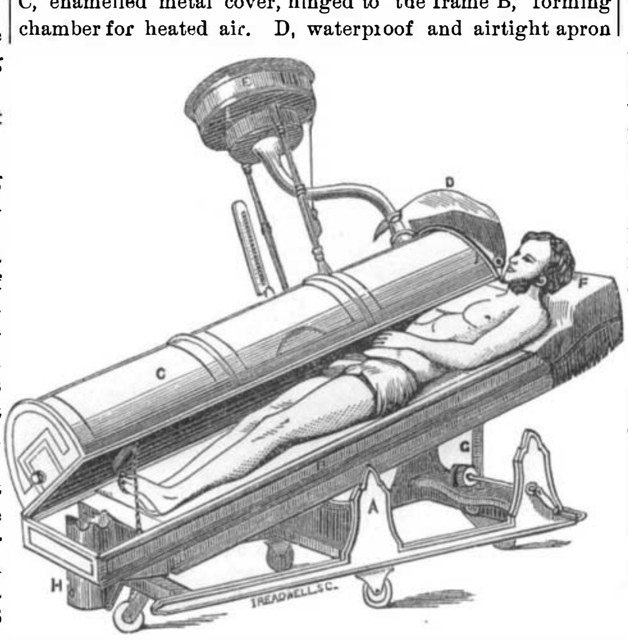
Several new methods of producing gas for illuminating purposes have of late been brought before the public, and among others is the process invented by Mr. Kromschröder. This consists in simply passing air through the vapor of a light hydrocarbon, the two combining and forming a gas of high illuminating power. The process has been in operation for about three months at Great Marlow, in Buckinghamshire, where we had the opportunity of examining it on Saturday last. The town of Great Marlow, however, has only been lighted regularly with the new gas for the past three weeks, its previous use having been intermittent and experimental, the ordinary coal gas having also been used. So successful, however, were these experimental trials that the Kromschröder gas is now regularly consumed, and the manufacture of coal gas is discontinued. The apparatus for the production of the gas is of a very simple character, and is erected in the gas works of the town. It consists of a sheet iron chamber 5 feet long, 4 feet wide, and 3 feet 6 inches high, the lower portion being 2 feet wider than the upper part for a hight of about 12 inches. In the upper chamber is placed a valve arrangement driven by clockwork and by which atmospheric air is forced into the lower or enlarged portion. Here it is made to pass through a mass of open fiberous material, the lower part of which is kept immersed in a liquid hydrocarbon. The air in its passage combines with the vapor of the hydrocarbon in the proportion of 70 parts of air to 30 of the vapor. In this condition the gas—for such it has now become—is conducted from the mingling chamber by a pipe into a receiver, capable of containing 100 cubic feet of the gas. As soon as this receiver is filled, its contents are discharged into the gas holder which was formerly used for the storage of coal gas, and which has a capacity of 6,000 feet. The reason for having the intermediate receiver is that the incorporating apparatus, although of ample power for producing the required quantity of gas, does not give sufficient pressure to lift the large holder, which is 30 feet in diameter. The time required to fill the large holder, or, in other words, to manufacture 6,000 feet of gas, is five hours. From the large holder the gas is supplied direct to the town, there being no purifiers or other apparatus required. The four main requirements in a gas for illuminating purposes are quality, cheapness, permanency, and capability of travel. As regards the first point, it was shown by photometric experiments that, with a burner consuming $3\frac{1}{2}$ feet per hour, a light equal to twenty candle gas was obtained, which is charged to consumers at 3s. 3d. per thousand feet, and this solves the second point. The permanency of this gas has been proved by allowing it to remain for three weeks in a holder subjected to the various temperatures, when a loss of 33 per cent was found to have been sustained. Lastly, it has been made to travel through $4\frac{1}{2}$ miles of pipes, and from its nature there is no doubt that it will travel any reasonable distance. The success of the gas is stated by its inventor to be due to the exact proportioning of the air and hydrocarbon vapor, a result he has only arrived at after several years of careful experimental research. Those proportions are, as already observed, 70 parts air to 30 of the vapor. To insure this result a hydrocarbon of constant specific gravity is used, that gravity being 6 70. Mr. William Bruff, C. E., is interesting himself in this invention, and it is from his experiments that the foregoing conclusions are deduced. The photometric experiments were witnessed and checked by ourselves. In the evening a drive round the town enabled a very satisfactory opinion to be formed of the gas as an illuminator, which opinion was strengthened by the use of the same gas at the hotel where the party of engineers and scientific gentlemen who had been inspecting the gas dined. Mr. Kromschröder, who explained the process of manufacture, observed that the gas is designed not so much to supersede coal gas in large towns as to afford a means of cheap gas light where coal gas could not be had. So far as the experiments go, the Kromschröder gas would seem well adapted to this purpose, and we wish its inventor success.—*Engineering.*

NEW TURKISH BATH.

The Turkish bath, as commonly practiced, consists in placing the patient in an apartment heated by stove or pipes to a temperature of 110° to 120°; in a short time, as soon as the pores begin to open, the patient passes into a still hotter chamber, where there is a temperature of from 150° to 210°. Here he remains until profuse perspiration is induced, and then, if he desires, enters a room heated still higher. He then passes into a wash room having a reduced temperature, is washed with warm water, then cooled with the spray bath; he then plunges into a swimming bath at the ordinary atmospheric temperature, which completes the ablutions.

The Turkish bath is a beautiful luxury and has but one discomfort, to wit, the highly heated atmosphere of the perspiring chambers. This is very oppressive to many persons; and to provide a portable bath as well as to overcome the difficulty just mentioned is the object of the present improvement, made public in the British *Medical Journal*:

A is the carriage upon which the bath rests, the wheels of which are so arranged that the whole apparatus can be turned completely round in a space little more than its own length. B, the frame and spring mattrasses fitted with centers to the carriage A, and forming the bottom of bath. C, enamelled metal cover, hinged to the frame B, forming chamber for heated air. D, waterproof and airtight apron



to prevent escape of heated air at the top of the bath. E, cistern for shower bath. F, pillow, with hinged head board to turn up when the bath is not in use. G, rack and pinion for raising or lowering the bath to the level of a bed, for use of an invalid. H, heating apparatus.

This invention is designed to supply to the public a portable Turkish bath in a complete and simple form. The advantages of the patent over the ordinary public Turkish bath are these: The heat can be raised in less than ten minutes to 180° Fah., and to the full temperature of 220° Fah. in fifteen minutes. The heat is obtained from gas, spirit, or other suitable means; it is under perfect control, and can be maintained at any degree, up to 220 Fah., that may be required. A shower bath is attached, by means of which a copious discharge of tepid or cold water can be obtained, suddenly or gradually, at the pleasure of the bather or attendant.

The head may, if required, be kept out of the bath in cool air. The bath offers in this respect one of the advantages of the sand bath, in which the entire body, with the exception of the head, is covered. It is probable that the therapeutic effects of the bath, with and without the exposure of the head to the heated air, may be very different.

Heating Power of Different Fuels.

A practical method of determining the heating power of fuel has recently been given by E. Seidler in the *Zeitschrift für Zucker Industrie.* The object is attained by first drying some 100 lbs. of the fuel at 1,000°, and noting the loss in weight; then by burning a measured amount, 2,000 lbs. for instance, weighing the ashes and cinders, and, after allowing $\frac{1}{4}$ per cent for ashes carried off by the draft, calculating the amount of combustible in the fuel; for example, supposing the fuel was found to stand as follows: Water, 40·75 per cent; ashes and cinders, 17·0 per cent; ashes carried off by draft, ·25; total, 58·0 per cent, leaving 42 per cent of combustible in the fuel; 2 per cent may be subtracted from the percentage of ashes and cinders for the coal which falls between the bars of the grate. For peat, multiply the percentage of combustible thus formed by the factor 7, and deduct from that the percentage of water in the fuel, to arrive at the amount of water in pounds which will be evaporated by one pound of the fuel; for example, in the above case, $0{\cdot}42 \times 7 = 2{\cdot}94$, which $- 0\ 4075 = 2{\cdot}5325$. A ton of such fuel then will evaporate $2000 \times 2{\cdot}5325 = 5065$ lbs. water at 0°, developing $5065 \times 640 = 2{,}241{,}600$ heat units. If the water used is run into the boiler at a higher temperature, 20° for example, the amount that can be evaporated by one tun is $\frac{3{,}241{,}600}{620} = 5228$ lbs.

EN ROUTE TO THE GREAT EXPOSITION.—LETTER FROM UNITED STATES COMMISSIONER PROFESSOR R. H. THURSTON.

NUMBER 2.—Continued

LONDON, JUNE 10, 1873.

The day in Glasgow afforded time to visit the great shipbuilding establishment where Randolph and Elder did so much toward the introduction of the "compound" engine and of iron ships, and to see the University of Glasgow where James Watt worked as a repairer of instruments, and where he made himself a name more enviable than was ever won by the sword, and not less enduring.

GLASGOW UNIVERSITY

has just been driven from the old structure which has so great historical interest, and is just becoming reëstablished in a noble pile of buildings at the summit of a high hill at the extremity of a beautiful park, at the west end of the city, where its surroundings are quite in keeping with the architectural beauty of the edifice itself. The new university buildings will, when completed, have cost about one and a half millions of dollars. Something more than one half the sum was contributed by the public spirited citizens of Glasgow. The floor space amounts to about six acres. The buildings are as convenient in their interior arrangements as they are beautiful on the exterior, and the visitor is compelled to admire alike the intelligence which has sustained and encouraged the growth of this noble institution and that which conducts its academic course. (We published an engraving of this structure on page 179 of our volume XXVII.)

The old model of the Newcomen steam engine, which, when sent to Watt for repair, first attracted his attention to the defects of then existing machines for applying the power of steam, and prompted him to make the intelligent investigations which led him to its improvement, is carefully preserved here; and we stood by it a long time, examining with interest its every part, and enjoying, with rarely equaled pleasure, the many historical associations which it brought to mind. We were pleased to learn that nothing, among the large and interesting collections of the University, attracts more attention from visitors than this battered and discolored old model.

THE LATE PROFESSOR RANKINE.

The University has met with a serious loss during the past year in the death of Professor Rankine, who will be ever remembered as one who, at the time of his death, had done more than had ever been done before in the application of science to practical investigations, and, particularly, as the first to give practical shape to the known scientific principles involved in the construction of steam and other heat engines, and in naval architecture. The city of Glasgow should build a monument to his memory, nobler than any of those which now adorn St. George's Square.

SHIPBUILDING ON THE CLYDE.

In our journey to and from Govan—the village just below the city, in which the shipbuilding establishment of Elder & Co. is situated—we counted some fifty iron steamers, in all stages of construction, and probably one third more might be laid down in the yards. Business has been severely checked by the recent rise in price of stock and labor, in consequence of strikes here and in the iron and coal producing districts. Very little new work is projected, and the consequences of the movement seem likely to be a serious loss of trade and much consequent suffering among the working people who are daily being thrown out of work. Iron which, a year ago, was worth fifty or fifty-five shillings a tun to-day costs a hundred, and all other expenses have risen greatly, and sometimes proportionally. Contracts are therefore made elsewhere, and Glasgow workmen must suffer at home, or must emigrate to some busier spot, unless a change for the better takes place here.

Elder & Co. now employ some 2,500 men, and have facilities for employing 6,000 or more. They are building seven or eight ships, and have room to lay down a half dozen more. Their new engine shop is one of the finest in the world, and is splendidly arranged for their work. Traveling cranes, radial drills, steam riveting machines, and very large planing and slotting machines are well placed, and small tools in considerable variety, but not equally creditable in design and construction, are placed out of the way on lofts, above the larger tools.

This firm began many years ago the construction of the compound engine, and were among the very first to make it a specialty. They were a long time pushing it into use, but the introduction of surface condensation in sea going vessels, and the gradual rise of steam pressure which succeeded, enabled them to exhibit more and more convincingly the economical superiority of that plan, and they are now reaping the harvest which they fully deserve. They do more work by far than any other firm on the Clyde.

A large amount of capital is invested in Glasgow in other branches of industry, one of the most important being the manufacture of chemicals. Her manufactures and her commerce have, together, produced rapid growth in wealth and population. The city now contains nearly 600,000 people.

"See what a change trade's golden wand can do!
As if by magic, make a village spring
To all the glories of a capital."

We were able to spend a few hours in Edinburgh, and there visited the old castle, the history of which is so familiar to every school boy. Thence we came to London by night train. It was by no means a comfortable ride, for the managers of the road have not yet exhibited a very strong desire to make their patrons comfortable, and have not introduced sleeping cars. R. H. T.